Nitrogen yields from sown pasture components in cocksfoot based pastures in a temperate environment

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Cocksfoot (orchardgrass; *Dactylis glomerata* L.) is a persistent pasture grass in temperate dryland pastoral farming systems. Yield is strongly reliant on nitrogen (N) availability either from inorganic fertilisers of companion legumes. In mixtures, legume suppression by cocksfoot reduces N availability and therefore grass yields. In practice, long term environmental and financial sustainability are unlikely to be maintained in systems heavily reliant on inorganic N fertilisers. Thus use of companion legumes which can produce, survive and persist within grass based pastures can be used to transfer nitrogen and increase total dry matter yields.

Methodology

The replicated (*n*=6) 'MaxClover' grazing experiment was established on a Templeton silt loam (Udic Ustochrept) soil in autumn of 2002. Here, data for Years 3 (2004/05) to 7 (2008/09) are presented. Full descriptions of methodology have been reported previously (Mills *et al*., 2008). Briefly, cocksfoot (CF) was established in binary combinations with either subterranean (Sub, *T. subterraneum*), balansa (Bal; *T. michelianum*), white (Wc; *T. repens*) or Caucasian (Cc; *T. ambiguum*) clovers. Controls were a perennial ryegrass (*Lolium perenne*)/white clover (RG/Wc) pasture and a lucerne (Luc; *Medicago sativa*) monoculture. In grass based pastures, dry matter (DM) production was measured from a 0.2 m^2 quadrat taken from exclosure cages at 20-90 day intervals. For lucerne, 5x0.2 m^2 quadrats/plot were cut immediately prior to grazing with regrowth durations of 31-122 d. Regrowth durations were extended during periods of summer water stress or in winter months. The N% of the green herbage of the sown pasture components was determined by NIRS and N yield (kg/ha) calculated. Data were analysed by ANOVA in Genstat 12. Means were separated by Fishers' protected LSD (α=0.05) when significant.

Results and discussions

Nitrogen yields from the green herbage of sown pasture components ranged from 79 kg N/ha/yr from the RG/Wc pastures in Year 7. In these pastures sown species represented 34% of the total annual yield of 7.0 t DM/ha/yr (Mills *et al*., 2008). The highest N yield of 657 kg N/ha/yr was from the lucerne monoculture in Year 5, which produced 17.3 t DM/ha/yr. The N yield from the CF/Sub pasture was highest (P<0.001) of the pastures in three out of the five years. Fig 1a shows that the yield of pasture grasses was directly proportional to N availability. Annually, a strong linear relationship (R^2=0.94) indicated an average N% of 3.1±0.05% which, for cocksfoot, would allow leaf photosynthesis at >80% of potential maximum rate, when no other factor was limiting (Peri *et al*., 2002). Similarly, the linear relationship (R^2=0.99) between green herbage legume yield and its associated N yield indicated an average annual N% of 3.9±0.04%. As expected, this was higher (~24%) than that of the companion grasses which relied on N uptake from the soil. Of the grass based pastures, those containing the annual subterranean or white clovers generally had the highest sown species N yields (Table 1). In this experiment cocksfoot was successfully established in combination with both subterranean and white clovers. The annual clover produced high quality feed and supplied N for the cocksfoot in spring while the summer active white clover contributed most in moist summers.

Conclusions

The conservative relationship between nitrogen and grass yield highlights the contribution of annual and perennial clovers to maintaining productivity in dryland pastures. Alternatively, using monoculture of lucerne produced the highest overall DM and N yields of these grazed pastures.

References

Mills, A., Smith, M. C., Lucas, R. J. and Moot, D. J. 2008. Dryland pasture yields and botanical composition over 5 years under sheep grazing in Canterbury. *Proceedings of the New Zealand Grassland Association*, 70, 37-44.

Peri, P. L., Moot, D. J., McNeil, D. L., Varella, A. C. and Lucas, R. J. 2002. Modelling net photosynthetic rate of field-grown cocksfoot leaves under different nitrogen, water and temperature regimes. *Grass and Forage Science*, 57, 61-71.

Table 1. Nitrogen yield (kg N/ha) of the sown pasture components (grass and/or legume species) in Years 3-7 of grazed dryland pastures established in 2002 at Lincoln University, Canterbury, New Zealand. Nitrogen yields were calculated from N% of green herbage samples and green herbage yield.

			Year			
Pasture	2004/05	2005/06	2006/07	2007/08	2008/09	Mean
CF/Sub	321 $_{b}$	347 $_{a}$	251 $_{bc}$	303 $_{b}$	260 $_{b}$	296
CF/Balansa	283 $_{b}$	253 $_{b}$	196 $_{d}$	165 $_{c}$	110 $_{cd}$	201
CF/White	343 $_{b}$	235 $_{b}$	278 $_{b}$	192 $_{c}$	139 $_{c}$	237
CF/Caucasian	213 $_{c}$	176 $_{c}$	237 $_{bcd}$	184 $_{c}$	129 $_{c}$	188
RG/White	294 $_{b}$	213 $_{bc}$	221 $_{cd}$	151 $_{c}$	79 $_{d}$	192
Lucerne	660 $_{a}$	327 $_{a}$	657 $_{a}$	518 $_{a}$	504 $_{a}$	533
Mean	352	259	307	252	204	275
SEM	23.0	19.1	17.8	20.7	14.9	
Sig	***	***	***	***	***	

Note: ***=P<0.001. CF=cocksfoot; RG=ryegrass. Numbers followed by the same subscript letter are not different at the P=0.05 level. SEM is standard error of the mean.

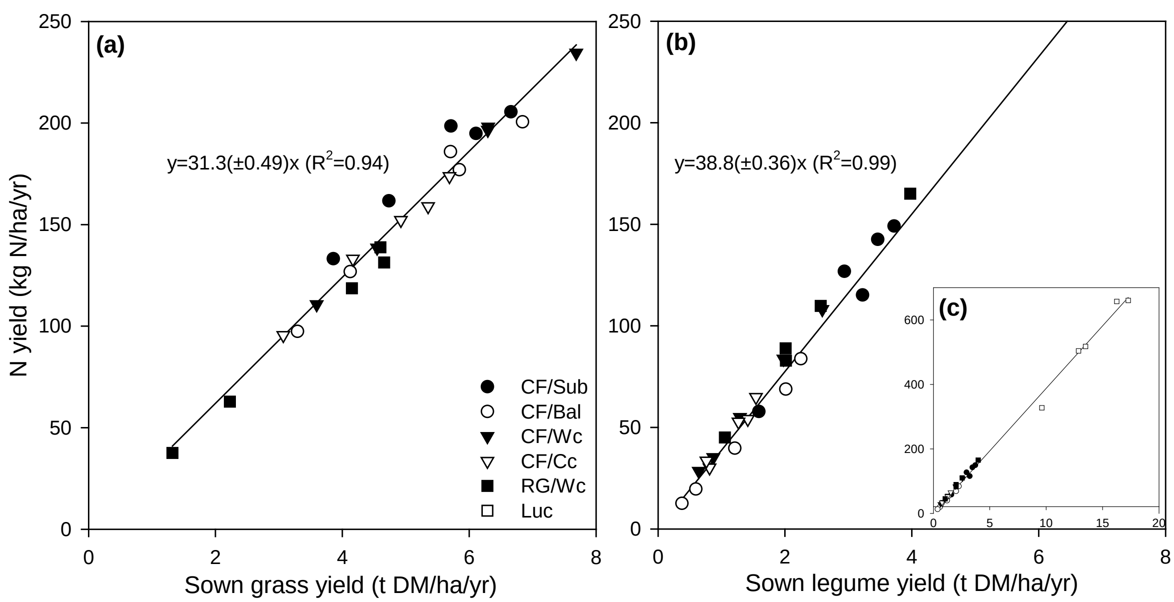

Figure 1. Relationship between N yield (kg N/ha/yr) and (a) green sown grass and (b) green sown legume herbage of six dryland pastures at Lincoln University, Canterbury, New Zealand from 2004/05 to 2008/09. See text for treatment acronyms. Insert (c) shows position of the lucerne dataset in the common regression applied to all legumes.